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UNITED STATES PATENT APPLICATION

OF

SUNG-SU JUNG

AND

YOUN-KEUN KWAK

FOR

SYRINGE FOR FABRICATING LIQUID CRYSTAL DISPLAY PANEL

[0001] The present application claims the benefit of Korean Patent Application No. 35417/2003 filed in Korea on June 2, 2003, which is hereby incorporated by reference.

## BACKGROUND OF THE INVENTION

### FIELD OF THE INVENTION

[0002] The present invention relates to fabrication of a liquid crystal display panel and, more particularly, to a syringe for fabricating a liquid crystal display panel.

### DESCRIPTION OF THE RELATED ART

[0003] In a liquid crystal display device, data signals corresponding to picture information are individually supplied to liquid crystal cells arranged in a matrix. The light transmittance of each liquid crystal cell is controlled to display a desired picture. The liquid crystal display device includes a liquid crystal display panel having the liquid crystal display cells and a driver integrated circuit (IC) for driving the liquid crystal cells. The liquid crystal display panel also has a color filter substrate and a thin film transistor array substrate facing each other with a liquid crystal layer positioned between the color filter substrate and the thin film transistor array substrate.

[0004] Data lines and gate lines are formed on the thin film transistor array substrate of the liquid crystal display panel. The data lines and the gate lines cross at right angles, thereby defining the liquid crystal cells adjacent to each of the crossings. The data lines transmit a data signal supplied from the data driver integrated circuit to the liquid crystal cells. The gate lines transmit a scan signal supplied from the gate driver integrated circuit to the liquid crystal cells. The gate driver integrated circuit sequentially supplies scan signals to the gate lines so that the liquid crystal cells arranged in the matrix can be sequentially selected line by line. A data signal is supplied to the selected one of the data lines of liquid crystal cells from the data driver integrated circuit.

[0005] A common electrode and a pixel electrode system are respectively formed on the inner side of the color filter substrate and the inner side of the thin film transistor array substrate. An electric field is applied across the liquid crystal layer using the common electrode and the pixel electrode. More specifically, pixel electrode is formed in each liquid crystal cell on the thin film transistor array substrate. The common electrode is integrally formed over the entire surface of the color filter substrate. Therefore, by controlling a voltage applied to the pixel electrode when a voltage is applied to the common electrode, light transmittance of the individual liquid crystal cells can be controlled. To control the voltage applied to the pixel electrode of liquid crystal cells, thin film transistors used as switching devices are formed so that each correspond to a liquid crystal cell.

[0006] Elements of a related art liquid crystal display device will now be described. FIG. 1 is a plan view of the unit liquid crystal display panel having a thin film transistor array substrate and a color filter substrate according to the related art.

[0007] As shown in FIG. 1, the liquid crystal display panel 100 includes an image display portion 113 where the liquid crystal cells are arranged in a matrix, a gate pad portion 114 connected to the gate lines of the image display portion 113, and a data pad portion 115 connected to the data lines. The gate pad portion 114 and the data pad portion 115 are formed along an edge region of the thin film transistor array substrate 101 that does not overlap with the color filter substrate 102. The gate pad portion 114 supplies a scan signal from the gate driver integrated circuit to the gate lines of the image display portion 113, and the data pad portion 115 supplies image information from the data driver integrated circuit to the data lines of the image display portion 113.

[0008] Data lines to which image information is applied and gate lines to which a scan signal is applied are provided on the thin film transistor array substrate 101. The data lines and the gate lines cross each other. Additionally, a thin film transistor for switching the

liquid crystal cells is provided at each crossing of the data lines and the gate lines. Pixel electrodes for driving the liquid crystal cells connected to the thin film transistors are provided on the thin film transistor array substrate 101. A passivation film protecting the thin film transistors is formed on the entire surface of the thin film transistor array substrate 101.

[0009] Color filters in the cell regions of the color filter substrate 102 are separated by the black matrix. A common transparent electrode is provided on the color filter substrate 102. The thin film transistor array substrate 101 and the color filter substrate 102 are attached to each other by a seal pattern 116 formed along an outer edge of the image display portion 113. Here, a cell gap is maintained uniformly by a spacer between the thin film transistor array substrate 101 and the color filter substrate 102.

[0010] In fabricating the liquid crystal display panel, a method for simultaneously forming a multiple liquid crystal display panels on a large-scale mother substrate is typically used. Thus, this method requires a process for separating the liquid crystal display panels from the large-scale mother substrate by cutting and processing the mother substrate having the plurality of liquid crystal display panels formed thereon. After a liquid crystal display panel is separated from the large-scale mother substrate, liquid crystal is injected through a liquid crystal injection opening to form a liquid crystal layer in the cell gap which separates the thin film transistor array substrate 101 and the color filter substrate 102. Then, the liquid crystal injection opening is sealed.

[0011] To fabricate a liquid crystal display panel, the following processes are generally required. First, the thin film transistor array substrate 101 and the color filter substrate 102 are separately fabricated on the first and second mother substrates. The first and second mother substrates are attached so that a uniform cell gap is maintained therebetween. The attached first and second mother substrates are cut into unit panels. Then, liquid crystal is

injected to the cell gap between the thin film transistor array substrate 101 and the color filter substrate 102.

[0012] A process of forming the seal pattern 116 along an outer edge of the image display portion 113 is required to attach the thin film transistor array substrate 101 and the color filter substrate 102.

[0013] The related art seal pattern forming method will now be described. FIGs. 2A and 2B illustrate a screen printing method to form a seal pattern.

[0014] As shown in FIGs. 2A and 2B, a screen mask 206 is provided with a pattern so that seal pattern forming regions are selectively exposed. A rubber squeegee 208 for selectively supplying a sealant 203 to the substrate 200 through the screen mask 206 is used to simultaneously form the plurality of seal patterns 216A-F. Thus, the plurality of seal patterns 216A-F is formed along each outer edge of the respective image display portion 213A-213F of the substrate 200, and liquid crystal injection openings 204A-204F are formed at one side of each image display portion 213A-213F. The openings 204A-204F are for injecting liquid crystal into the respective cell gaps between the thin film transistor array substrate 101 and the color filter substrate 102. The seal patterns 216A-216F prevent leakage of the liquid crystal.

[0015] In general, the screen printing method includes applying the sealant 203 on the screen mask 206 having seal pattern forming regions patterned thereon, forming the seal patterns 216A-216F on the substrate 200 through printing with the rubber squeegee 208, drying the seal pattern 216 by evaporating a solvent contained in the seal patterns 216A-216F, and leveling the seal patterns 216A-216F. The screen printing method is widely used because it has the advantage of processing ease. However, it has the disadvantage of wasting sealant. More particularly, sealant is wasted because sealant is applied over the entire surface of the screen mask 206 and then the seal patterns 216A-216F are

simultaneously printed with the rubber squeegee 208. As a result, excess sealant material, which is not printed, is discarded. When fabricating a large-scale liquid crystal display panel, more sealant is consumed, thereby increasing a unit cost of the liquid crystal display device. In addition, the screen printing method has another disadvantage in that a rubbed alignment layer (not shown) formed on the substrate 200 is degraded as a result of the screen mask 206 being brought into contact the substrate 200. The degradation of the rubbed alignment layer degrades picture quality of the liquid crystal display device.

[0016] Therefore, to overcome the shortcomings of the screen printing method, a seal dispensing method has been proposed. FIG. 3 is an exemplary view of a dispensing method for forming a seal pattern in accordance with the related art.

[0017] As shown in FIG. 3, while a table 310 with the substrate 300 loaded thereon is being moved in forward/backward and left/right directions, a plurality of seal patterns 316A-316F are formed along each outer edges of each of the image display portions 313A-313F formed on a substrate 300 by applying a certain pressure to the plurality of syringes 301A-301C aligned and fixed at a support 314 to discharge sealant through nozzles 302A-302C individually provided at one end portion of each of the syringes 301A-301C.

[0018] In this seal dispensing method, since the sealant is selectively supplied to the region where the seal patterns 316A-316F are to be formed, sealant consumption is reduced. In addition, because the syringe is not in contact with the alignment layer (not shown) of the image display portions 313A-313F of the substrate 300, the rubbed alignment layer is not damaged, thereby avoiding degradation of, the picture quality of the liquid crystal display device is not degraded.

[0019] However, in the related art syringe of the liquid crystal display panel, since sealant is discharged through the nozzles 302A-302C, which are individually provided at an end of each of the plurality of syringes 301A-301C, it is not possible to form such seal patterns

316A-316F if the liquid crystal display panel is small due to restriction of a space taken by the syringes 301A-301C. In other words, if a liquid crystal display panel is a small model, seal patterns 316A-316F cannot be formed at each outer edge of the image display portions 313A-313F due to mutual interference between syringes 301A-301C.

#### SUMMARY OF THE INVENTION

[0020] Accordingly, the present invention is directed to a syringe for fabricating a liquid crystal display panel that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

[0021] An object of the present invention is to provide a syringe for fabricating a liquid crystal display panel capable of preventing mutual interference of adjacent syringes in performing a dispensing operation on a liquid crystal display panel, especially, but not limited to, a small model liquid crystal display panel.

[0022] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0023] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, a syringe for fabricating a liquid crystal display panel comprises a body portion having a dispensing material contained therein; a plurality of nozzles to supply the dispensing material received from the body portion to a substrate of the liquid crystal display panel; and a connection portion to couple the nozzles with the body portion, the nozzles being provided on a bottom surface of the connection portion.

[0024] In another aspect, a syringe for fabricating a liquid crystal display panel comprises a body having a dispensing material contained therein; and a plurality of nozzles provided at one end portion of the body to supply the dispensing material onto a substrate.

[0025] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention. In the drawings:

[0027] FIG. 1 is a plan view of the unit liquid crystal display panel formed by a thin film transistor array substrate and a color filter substrate according to the related art;

[0028] FIGs. 2A and 2B illustrate formation of a seal pattern through a screen printing method in accordance with the related art;

[0029] FIG. 3 illustrates formation of a seal pattern through a seal dispensing method in accordance with the related art;

[0030] FIG. 4 is a view showing a syringe for a liquid crystal display panel in accordance with an exemplary embodiment of the present invention;

[0031] FIG. 5 is a view showing formation of seal patterns on a substrate by applying the syringe for a liquid crystal display panel in accordance with an exemplary embodiment of the present invention; and

[0032] FIG. 6 is a sectional view along one edge of an exemplary liquid crystal display panel.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0033] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[0034] FIG. 4 is a view showing a syringe for a liquid crystal display panel in accordance with an exemplary embodiment of the present invention.

[0035] With reference to FIG. 4, a syringe for a liquid crystal display panel includes a body 410 filled with a dispensing material, a cap part 411 provided at an upper end of the body 410, a connection portion 412 coupled to a lower end of the body 410, and first and second nozzles 420A and 420B on the connection portion 412 for supplying the dispensing material filled in the body 410 to a substrate.

[0036] FIG. 5 is a view showing formation of seal patterns on a substrate by applying the syringe for a liquid crystal display panel in accordance with an exemplary embodiment of the present invention.

[0037] With reference to FIG. 5, there are provided a substrate 500 having a plurality of image display portions 510A-510F formed thereon, a plurality of syringes 530A-530C for supplying sealant on the substrate 600 to simultaneously form a plurality of seal patterns 540A-540F along each outer edge of the plurality of image display portions 510A-510F; and a support 520 for positioning and holding the plurality of syringes 530A-530C. The plurality of syringes 530A-530C include bodies 531A-531C in which sealant material is filled, connection portions 533A-533C coupled to each lower end of the bodies 531A-531C, and nozzles (532A and 532B), (532C and 532D) and (532E and 532F) disposed in pairs on the connection portions 533A-533C for supplying the sealant filled in the bodies 531A-531C to the substrate 500. The sealant material or other dispensing material can be dispensed in a controllable manner according to a gas pressure applied via gas inlets (not shown) onto the material in the respective bodies 531A-531C.

[0038] The substrate 500 may be a first large-scale mother substrate made of glass on which a plurality of thin film transistor array substrates are formed, or a second large-scale mother substrate made of glass on which a plurality of color filter substrates are formed.

[0039] Though two nozzles (532A and 532B), (532C and 532D) and (532E and 532F) are provided on each of the connection portions 533A-533C, more nozzles can be provided corresponding to the number of image display portions formed on the substrate 500. For example, if nine image display portions are formed on the substrate 500, three nozzles can be provided at each the connection portions. Similarly, while three syringes 530A-530C are provided in the exemplary illustrated embodiment, the number of syringes can be varied according to number of image display portions or other application parameters.

[0040] The two or more nozzles (532A and 532B), (532C and 532D) and (532E and 532F) individually provided on the connection portions 533A-533C can be fabricated to be movable at least in one direction of the connection parts 533A-533C to suitably correspond to the size of the plurality of image display portions 510A-510F formed on the substrate 500. Or, at least one of the nozzles may be fixed on each of the connection portions 533A-533C and aligned together with the plurality of syringes 530A-530C on the support 520 while the other remaining nozzles can be movable at least in one direction of the connection portions 533A-533C to suitably correspond to the size of the plurality of image display portions 510A-510F formed on the substrate 500.

[0041] As mentioned above, the syringe for fabricating a liquid crystal display panel in accordance with the present invention has a number of advantages. For example, because the plurality of nozzles are individually provided at the plurality of syringes corresponding to the number of plurality of image display portions formed on the substrate, seal patterns may be concurrently formed along each outer edge of the image display portions even if the number of the image display portions formed on the substrate increases. Thus, productivity

may be enhanced. In addition, seal patterns may be formed even in case of fabricating a small liquid crystal display panel.

[0042] In other words, referring back to the related art, if the liquid crystal display panel is too small, since syringes and gap controllers are individually provided at each of the plurality of dispensing units, seal patterns may not be formed due to the mutual interference between dispensing units. In comparison, however, in the present invention, the plurality of syringes are respectively formed at the plurality of dispensing units and fabricated to be movable corresponding to the size of the small liquid crystal display panel so that seal patterns may be formed along each outer edge of the plurality of image display portions suitably regardless of the size of the small liquid crystal display panel.

[0043] The seal patterns formed by the syringe in accordance with the present invention may be varied in their forms according to methods for forming a liquid crystal layer on the liquid crystal display panel. The method for forming the liquid crystal layer on the liquid crystal display panel is roughly divided into a vacuum injection method and a dropping method.

[0044] The vacuum injection method uses a liquid crystal injection opening of a unit liquid crystal display panel separated from a large-scale mother substrate. The liquid crystal injection opening is put in a container filled with a liquid crystal in a chamber in which a certain vacuum is set. Then, liquid crystal is injected into the liquid crystal display panel according to a pressure difference between an inner side and an outer side of the liquid crystal display panel by varying a degree of the vacuum in the chamber. After the liquid crystal is filled in the liquid crystal display panel, the liquid crystal injection opening is sealed to form the liquid crystal layer of the liquid crystal display panel.

[0045] The liquid crystal injection opening is defined as a region opened at one side of each seal pattern. Accordingly, in the case of forming the liquid crystal layer on the liquid

crystal display panel through the vacuum injection method, one portion of each seal pattern must be opened to function as the liquid crystal injection opening. The vacuum injection method as described above has the following problems.

[0046] First, it takes a long time to fill the liquid crystal into the liquid crystal display panel.

In general, the attached liquid crystal display panel with an area of several hundreds  $\text{cm}^2$  has a gap of a few micrometers ( $\mu\text{m}$ ). Thus, even with the vacuum injection method, which uses pressure difference, the injection of liquid crystal takes a long time. For instance, in the case of fabricating a liquid crystal display panel of about 15 inches, it takes 8 hours to fill the liquid crystal display panel with liquid crystal. Thus, because such a long time is taken during the fabrication of the liquid crystal display panel, the productivity is degraded. In addition, as the liquid crystal display panel increases in size, the time required for filling liquid crystal correspondingly increases, thereby further decreasing the filling efficiency of liquid crystal. Therefore, the vacuum injection method can hardly cope with the large-scale liquid crystal display panel.

[0047] Second, with the vacuum injection method, too much liquid crystal is consumed. In general, the actually injected quantity of liquid crystal in the vacuum injection method is very small compared to the quantity of liquid crystal filled in the container. When liquid crystal is exposed in the air or to a specific gas, it reacts with the gas and degrades. Thus, even if liquid crystal in a container is filled into a plurality of liquid crystal display panels, a large quantity of liquid crystal remaining after the filling has to be discarded, thereby increasing the overall unit price of the liquid crystal display and decreasing price competitiveness.

[0048] In order to overcome such problems of the vacuum injection method, a dropping method is proposed.

[0049] In the dropping method, liquid crystal is dropped and dispensed on a plurality of thin film transistor array substrates fabricated on a first large-scale mother substrate or on color filter substrates fabricated on a second large-scale mother substrate. The first and second mother substrates are then attached to each other so that liquid crystal is uniformly distributed on entire image display regions by the attaching pressure, thereby forming a liquid crystal layer in each image display region. In other words, when forming the liquid crystal layer on the liquid crystal display panel through the dropping method, since liquid crystal is directly dropped on the substrate rather than being filled from an external source, seal patterns may be formed in a closed pattern encompassing the image display portions to prevent leakage of liquid crystal to outside of the image display portions.

[0050] Liquid crystal may be dropped using the dropping method in a shorter time as compared with the vacuum injection method, and the liquid crystal layer may be formed more quickly even though the liquid crystal display panel is large in size. In addition, since only enough liquid crystal is dropped as required, discharge of excess expensive liquid crystal is avoided, thereby avoiding the increase in the unit price of the liquid crystal display panel as compared with the vacuum injection method. As a result, price competitiveness is increased. Unlike the vacuum injection method, in the dropping method, after the liquid crystal layer is formed, the first large-scale mother substrate on which the plurality of thin film transistor array substrates are formed and the second large-scale mother substrate on which the plurality of color filter substrates are formed are attached. Then, unit liquid crystal display panels are separated from the attached large-scale mother substrates.

[0051] When using the dropping method, if the seal patterns are formed with thermosetting sealant, the sealant may flow out while being heated during the follow-up process of attaching the liquid crystal display panel, thereby contaminating the dropped liquid crystal.

Thus, to avoid such a problem, the seal patterns are preferably formed with an ultraviolet (UV)-hardening sealant, or a mixture of UV-hardening sealant and thermosetting sealant.

[0052] The syringe for fabricating a liquid crystal display panel in accordance with the present invention may be not only applied to formation of seal patterns on the substrate by filling it with sealant but may also be applied to dropping liquid crystal on the substrate through the dropping method as described above. Namely, the plurality of syringes corresponding to the plurality of image display portions formed on the substrate are filled with liquid crystal, and liquid crystal is dropped to the plurality of image display portions respectively through ones of the plurality of nozzles provided on the plurality of syringes.

[0053] As mentioned above, in the case of dropping liquid crystal using the syringe for the liquid crystal display panel of the present invention, liquid crystal may be quickly dropped on the image display portions because the plurality of nozzles are respectively provided on the plurality of syringes corresponding to the number of image display portions formed on the substrate even if the number of image display portions increases. As a result, productivity may be enhanced. In addition, since the plurality of nozzles are respectively provided at the plurality of syringes and movable corresponding to the size of the small liquid crystal display panel, liquid crystal may be dropped to the plurality of image display portions suitably corresponding to the size of the small liquid crystal display panel.

[0054] In another embodiment, an Ag (silver) dot may be formed on the substrate using the syringe for a liquid crystal display panel in accordance with the present invention. The Ag dot will now be described with reference to FIG. 6.

[0055] FIG. 6 illustrates a sectional structure of one edge of the liquid crystal display panel. As shown in FIG. 6, a liquid crystal display panel is formed such that a thin film transistor array substrate 601 and a color filter substrate 602 are attached in a facing manner with a certain gap by a spacer 603 and a seal pattern 604. A liquid crystal layer 605 is formed in

the gap between the thin film transistor array substrate 601 and the color filter substrate 602. The thin film transistor array substrate 601 is formed having a protruded portion as compared to the color filter substrate 502. At the protruded portion, a gate pad portion connected to gate lines of the thin film transistor array substrate 601 and a data pad portion connected to data lines are formed.

[0056] In the image display portion of the thin film transistor array substrate 601, gate lines (to which a scan signal is applied from outside through the gate pad portions) and data lines (to which image information is applied through the data pad portions) are arranged to cross each other, and a plurality of thin film transistors for switching the liquid crystal cells is formed at each of the crossings of the gate lines and the data lines. In addition, a plurality of pixel electrodes connected to the thin film transistors are separately formed at cell regions. In the image display portions of the color filter substrate 602, color filters are formed in each of the cell regions that are separated by a black matrix. A common transparent electrode for driving the liquid crystal layer together with the pixel electrodes formed on the thin film transistor array substrate 601 is also formed on the color filter substrate 602. A common voltage line 607 for applying a common voltage to the common electrode 606 formed on the color filter substrate 602 is formed on the thin film transistor array substrate 601.

[0057] An Ag dot 608 is formed either on the thin film transistor array substrate 601 or the color filter substrate 602 to electrically connect the common voltage line 607 and the common electrode 606 so that the common voltage applied to the common voltage line 607 can be applied to the common electrode 606 using the Ag dot 608.

[0058] At least one or more Ag dots 608 are formed at each of the plurality of unit liquid crystal display panels fabricated on the large-scale mother substrate, which may be formed using the syringe in accordance with embodiments of the present invention. Namely, after

the plurality of syringes that correspond to the plurality of image display portions formed on the substrate are filled with silver, silver is discharged at each outer edge of the plurality of image display portions through respective ones of the plurality of nozzles provided on the plurality of syringes, thereby forming the Ag dot 608.

[0059] As mentioned above, also in the case of forming the Ag dot 608 using the syringe for the liquid crystal display panel in accordance with the present invention, the plurality of nozzles are provided at the plurality of syringes corresponding to the number of the plurality of image display portions formed on the substrate. Thus, even if the number of image display portion formed on the substrate increases, the Ag dots 608 may be quickly formed on each outer edge of the image display portions, thereby improving productivity. In addition, since the plurality of nozzles are provided at the plurality of syringes and fabricated to be movable corresponding to the size of the small liquid crystal display panel, the Ag dot 608 may be formed at each outer edge of the plurality of image display portions suitably corresponding to the size of the small liquid crystal display panel.

As described, the syringe for a liquid crystal display panel in accordance with the embodiment of the present invention has numerous advantages. For example, because the plurality of nozzles are provided at the plurality of the syringes corresponding to the number of image display portions formed on the substrate, even if the number of the image display portions formed on the substrate increases, seal patterns may be quickly formed. Similarly, even when dropping liquid crystal or forming the Ag dot, the process can be promptly performed, thereby enhancing productivity. In addition, because the plurality of nozzles are provided at the plurality of syringes and fabricated to be movable corresponding to the size of a small liquid crystal display panel, seal patterns can be suitably formed corresponding to the size of the small liquid crystal display panel, and the syringe of the present invention may be also used for the case of dropping liquid crystal or forming the Ag dot on the small

liquid crystal display panel. For example, for some liquid crystal display panels for devices such as PDAs, the nozzles can be positioned to be separated by less than about 10 cm, and for liquid crystal display panels such as cell phones or digital cameras, the nozzles can be separated by less than 4 cm. However, it should be recognized that the present invention is not limited to fabrication of small liquid crystal display panels but can be used in fabricating liquid crystal display panels of other sizes. Also, it should be recognized that the present invention can be applied to liquid crystal display panels smaller than that specified above.

[0060] It will be apparent to those skilled in the art that various modifications and variations can be made in the syringe for fabricating a liquid crystal display panel of the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention cover the modifications and variations of this invention provided that they come within the scope of the appended claims and their equivalents.

[0061] The present application also incorporates by reference U.S. Patent Publication No. 2003-0223030-A1 and Korean Patent Application No. 35416/2003 filed in Korea on June 2, 2003.